ETSI TECHNICAL REPORT

ETR 159

July 1995

Source: ETSI TC-RES

Reference: DTR/RES-03022

ICS: 33.060

Key words: DECT, mobility, GSM

Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Wide area mobility using the Global System for Mobile communications (GSM)

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Foreword

This ETSI Technical Report (ETR) was produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

In 1992 the Digital European Cordless Telecommunications (DECT) standard ETS 300 175 [1] to [9] and I-ETS 300 176 [10], was successfully adopted as the European standard for cordless telecommunications. Immediately after this process, the Technical Basis for Regulation (TBR) 006 [16], TBR 010 [17] and TBR 011 [18] were derived from the standard. In addition the Generic Access Profile (GAP) ETS 300 444 [19], and its respective TBR 022 [20], are being developed to describe the minimum requirements for DECT speech equipment, so that Portable Parts (PPs) can operate in all three Fixed Part (FP) environments (i.e. residential, business and public). These TBRs will be integrated in appropriate Common Technical Regulations (CTR) serving as an Europe-wide basis for approval of DECT equipment.

Conceptually the DECT standard is an air interface standard describing the technical parameters and protocol elements used on air. Accordingly, interfaces to other networks are not described but are explicitly included in the standard so that interworking with other networks can be implemented easily.

The DECT standard was written to allow cordless communications in three environments:

- the residential area;

- in business applications; and

- in public systems.

The first two applications are not dependent on commonly used DECT local networks (DECT reference model) therefore any proprietary solution is appropriate so long as the interface towards the Global Networks Integrated Services Digital Network (ISDN) and Public Switched Telephone Network (PSTN) is maintained.

This situation changes when a larger public access system is to be implemented, so that user mobility is possible on a country-wide (Europe-wide) basis. In this case, mobility related information has to be transmitted via the interfaces of the Global Network and appropriate call routing for roaming subscribers has to be implemented. These functions need to be embedded in the structure of the existing, standardised networks.

For the time being, the PSTN/ISDN Intelligent Network (IN) is not capable of handling the mobility related information but fortunately a dedicated IN structure is in the process of taking up this position. The Global System for Mobile communications (GSM) fixed network is a system containing all the necessary elements and functions to provide mobility to users of cordless terminal equipment.

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1 Scope

This ETSI Technical Report (ETR) describes the possible requirements when a DECT system is attached to a GSM fixed network.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 175-1: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 1: Overview".

[2] ETS 300 175-2: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical Layer (PHL)".

[3] ETS 300 175-3: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 3: Medium Access Control (MAC) layer".

[4] ETS 300 175-4: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 4: Data Link Control (DLC) layer".

[5] ETS 300 175-5: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 5: Network (NWK) layer".

[6] ETS 300 175-6: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 6: Identities and addressing".

[7] ETS 300 175-7: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 7: Security features".

[8] ETS 300 175-8: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 8: Speech coding and transmission".

[9] ETS 300 175-9: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 9: Public Access Profile (PAP)".

[10] I-ETS 300 176: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Approval test specification".

[11] ETR 043: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common interface; Services and facilities requirements specification".

[12] ETR 042: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); A Guide to the DECT features that influence the traffic capacity and the maintenance of high radio link transmission quality, including the results of simulations".

[13] ETR 056: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); System description document".

[14] Final Draft TCR-TR 013: "Network Aspects (NA); Network support of cordless terminal mobility".

[15] Draft prETS 300 370: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications/Global System for Mobile communications (DECT/GSM) inter-working profile; Access and mapping (Protocol/procedure description for 3,1 kHz speech service)".

[16] TBR 006: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); General terminal attachment requirements".

[17] TBR 010: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); General terminal attachment requirements: telephony applications".

[18] TBR 011: "Radio Equipment and Systems (RES); Attachment requirements for terminal equipment for Digital European Cordless Telecommunications (DECT); Public Access Profile (PAP) applications".

[19] ETS 300 444: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP)".

[20] TBR 022: "Radio Equipment and Systems (RES); Attachment requirements for terminal equipment for Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP) applications".

[21] 91/288/EEC: "Council Recommendation of 3 June 1991 on the co-ordinated introduction of digital European cordless telecommunications (DECT) into the Community".

3 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

AC	Authentication Centre
BS	Base Station
BSC	Base Station Controller
BSS	Base Station Subsystem
CCFP	Common Control Fixed Part
CDCA	Continuous Dynamic Channel Allocation
CEC	Commission of the European Communities
CTR	Common Technical Regulation
DAM	DECT Authentication Module
DCS 1800	Digital Cellular System 1800
DECT	Digital European Cordless Telecommunications
DMH	Dual Mode Handheld
DSS1	Digital Signalling System No. 1
EIR	Equipment Identity Register
FP	Fixed Part
GAP	Generic Access Profile
GSM	Global System for Mobile communications
HLR	Home Location Register
IN	Intelligent Network
INAP	Intelligent Network Application Part
ISDN	Integrated Services Digital Network
IWU	InterWorking Unit
LAN	Local Area Network
MAP	Mobile Application Part
MSC	Mobile Switching Centre
NA	Network Aspects

NSS	Network SubSystem
OMC	Operation and Maintenance Centre
ONP	Open Network Provision
PBX (PABX)	Private (Automatic) Branch eXchange
PAP	Public Access Profile
PP	Portable Part
PSTN	Public Switched Telephone Network
PTN	Private Telecommunications Network
R&D	Research and Development
RES	Radio Equipment and Systems
RF	Radio Frequency
RFP	Radio Fixed Parts
SIM	Subscriber Identity Module
SMG	Special Mobile Group
SPS	Switching Point and Signalling
SS7	CCITT Signalling System No. 7
TDMA	Time Division Multiple Access
VLR	Visited Location Register
WAN	Wide Area Network

4 Cost related issues

Unlike the GSM standard which defines the whole network infrastructure i.e. Mobile Switching Centres (MSC), registers to provide the mobility management (Home Location Register (HLR), Visitor Location Register (VLR), Authentication Centre (AC), Equipment Identity Register (EIR)) and the Operation and Maintenance Centre (OMC), DECT, as an air interface specification, is designed as an access system to existing networks. This enables operators to tailor and optimise their infrastructure to their specific needs and necessities, or, due to the fact that the DECT protocol stack has been structured in a similar way as GSM, a synergetic sharing of network infrastructure between DECT and GSM is feasible.

In other words the GSM operator is provided with the possibility to enhance the GSM Intelligent Network (IN) platform by using DECT as an access method to the GSM system in order to offer a DECT based public mobile service providing additional traffic in the existing GSM system, or optimising it.

4.1 The cost/mobility curve

DECT has been designed as a system capable of handling high traffic rates (around 10 000 Erlang per sq/km per floor). In this ETR the expression "stationary mobility" in contrast to "fast mobility" will be used to distinguish between DECT and GSM like mobility.

This design restriction to stationary mobility reduces the hardware and software efforts and gives the opportunity to build inexpensive, lightweight equipment with very long standby or traffic times. In addition the Time Division Multiple Access (TDMA) structure of DECT gives the opportunity to handle the mean value of 5 Erlangs of traffic with only one Base Station (BS) transmitter. This, together with the Europe-wide frequency allocation will lead to a price level for DECT equipment clearly under the price level for cellular equipment.

A public service based on DECT can be offered at a less expensive price than cellular services because of inexpensive mass market targeted equipment due to:

- the TDMA structure of the signal;

- absence of necessity for frequency planning due to Continuous Dynamic Channel Allocation (CDCA); and

- the positioning of appropriate Radio Fixed Parts (RFPs) below the rooftops in the covered areas where no expensive sites are required.

The following conclusions can be short listed:

- compared to the GSM system, DECT means:

    - restriction to stationary mobility (figure 1);

- restricted coverage (figure 2);

- where these restrictions are accompanied by:
  - cost reductions (investments and operating costs);
  - high system capacity in the covered area.

Today's communications systems can be ordered as follows, where the positioning of each system is from a qualitative point of view.

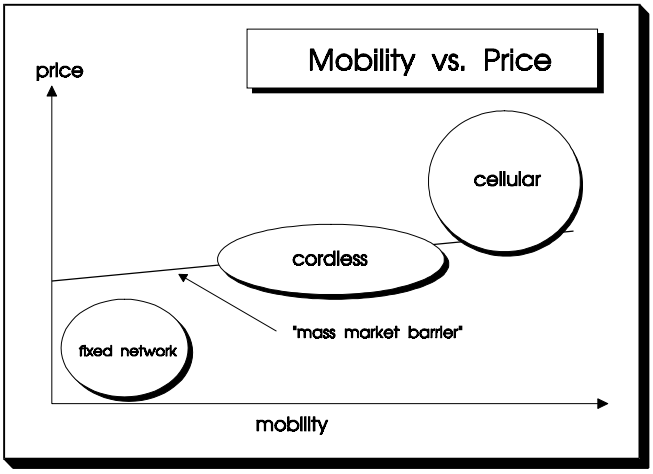

Figure 1: Mobility versus price (qualitative assessment)

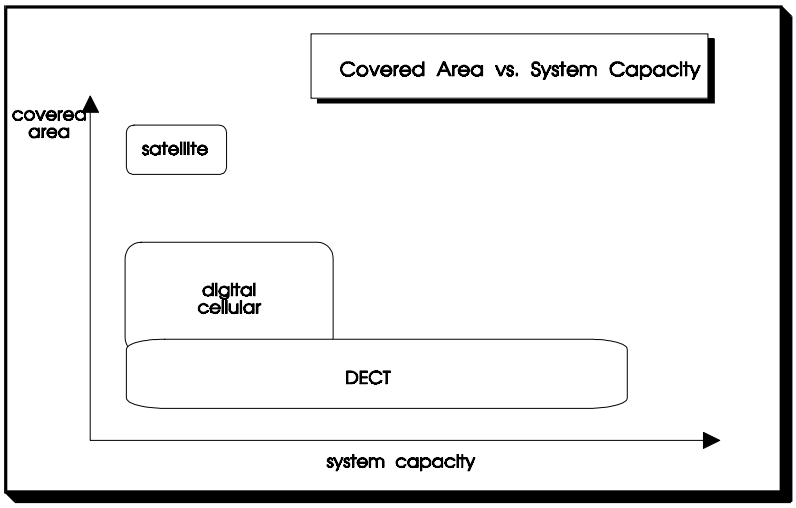

Figure 2: Coverage versus system capacity (qualitative assessment)

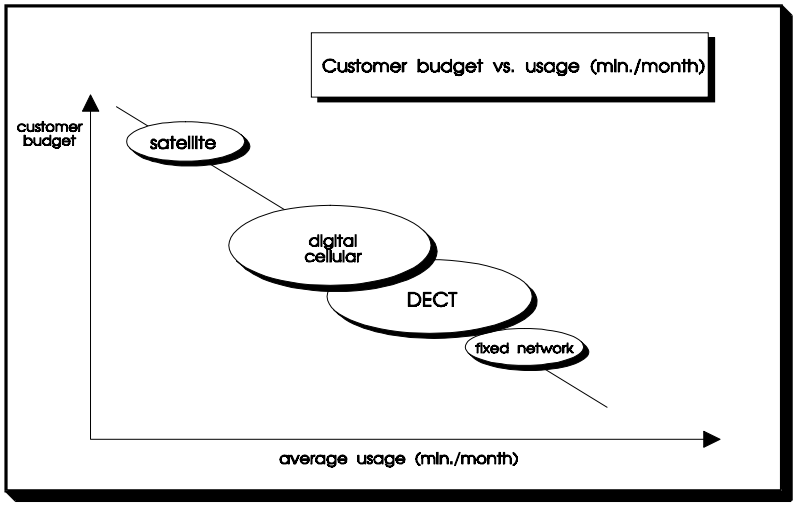

Figure 3: Customer budget versus usage (qualitative assessment)

4.2 Propagation related matters

Cordless systems, and therefore DECT, also by definition are specified with a restricted Radio Frequency (RF) output power. Consequently the range of such systems is limited to several hundred meters around a Radio Fixed Part (RFP). DECT, as a multicell-system, does not restrict the coverage to this relatively small area as the concatenation of several cells is possible. However, all cost related questions depend on the possible range between the handset and the RFP.

The number of Base Stations (BSs) increases according to the power of two of the inverse covering range for a certain area. Neglecting the economy of scale, investment as well as operating costs can be regarded as proportional to the number of BSs. This sometimes leads to the misunderstanding that a cordless system is not appropriate for a public service. There are some restrictions in coverage which have to be taken into account when planning a public access system based on DECT but the reversing effect of mass production of low priced equipment and the offered system capacity allow a public operator to offer a stationary mobility service at a very attractive price.

From a certain amount of traffic per sq/km, the price for the DECT telephony service should be considerably lower than the price for a cellular telephony service (GSM). With increasing traffic the price decreases rapidly. This process ends when finally almost reaching the price of the fixed telephony service.

Some conclusions can be short listed as follows:

- country-wide coverage with DECT is not appropriate;

- the offered traffic to the DECT system should be above a certain amount of traffic per sq/km;

- with increasing traffic service prices decrease significantly;

- a DECT telephony service should not be significantly more expensive than the fixed telephony service when the "mass market border" is crossed.

The service concept serving as a basis for this concept is presented in detail in clause 5.

4.3 Synergetic effects

From the block diagram of a DECT cordless access system, with a GSM fixed system as a backbone, directly several synergetic effects can be derived.

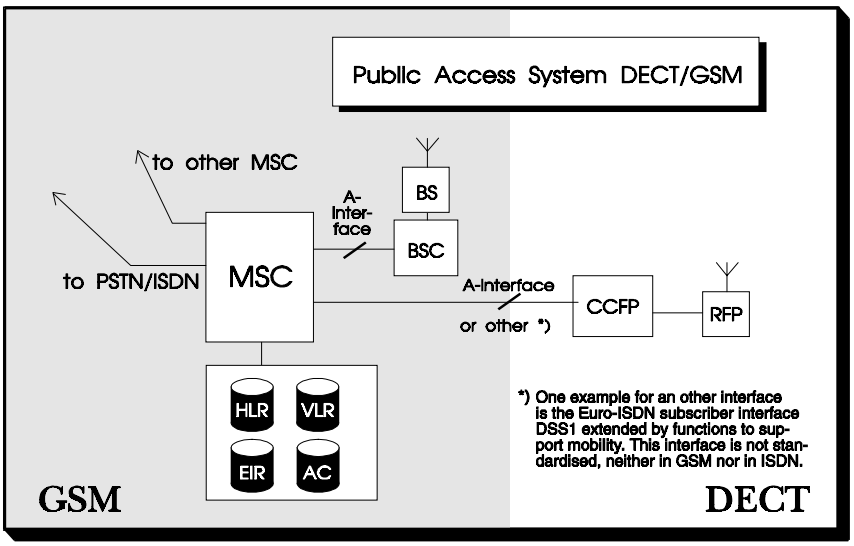

Figure 4: Block diagram public access system

The DECT system makes use of the following parts of the GSM system:

- GSM registers (HLR, VLR, EIR, AC);
- MSC;
- links to PSTN/ISDN;
- links to other MSC;
- link between GSM MSC and DECT Common Control Fixed Part (CCFP) (A- or other, see note);
- OMC, (not depicted).

NOTE: One example for another interface is the Euro-ISDN subscriber interface, DSS1, extended by functions to support mobility. This interface is not standardized, neither in ISDN nor in GSM. Even the DSS1 interface itself is not standardized in GSM but only in ISDN. The DECT access to GSM is one of the TC-SMG work items for Phase 2 + of GSM.

Synergetic effect I

The size and number of the first four items are traffic dependent so that the Erlang-B-law applies. This results in a better throughput the more links are existent between 2 endpoints. This fundamental law is not only applicable to links but as also for switches and storages.

Synergetic effect II

With a different service profile for the cellular and the cordless system the main traffic hours are different. The capacity planning of a system is done on the amount of traffic during the busy hour. By adding the traffic figures in their time slots (measurement slots) it can be proved that the resulting traffic during busy hour is less than the sum of each of the systems busy hour traffic. This rule applies again for links, switches and storages.

Synergetic effect III

Taking into account the economy of scale, the operating costs of telecommunications equipment is not proportional to their size and number (on the same site). If a second MSC has to be put into place for the additional traffic, e.g. a cordless system, the resulting operating costs are less than double for each individual MSC if both systems are placed in the same building. This synergetic effect applies to OMC, storages and MSC.

Other synergetic effects are more of an evolutionary nature. The implementation of GSM as a European wide (or even global) system is causing a relatively high investment for the operators and similarly a high effort in Research and Development (R&D) for the manufacturers. Therefore, there is a tendency that, for the time being (approximately till the year 2002), no other mobility supporting global system that could be used will be developed in Europe.

Using this system for cordless access means:

- shorter time to market;

- no major additional R&D effort necessary.

The combination of a GSM and a DECT public access system results in several synergetic effects so that it is possible to offer less expensive cordless and cellular services.

5 Service concept

Market research clearly indicates that a significant need for mobility exists. It is crucial that the underlying service concept for cordless public access meets the customer's needs and the pricing for the service is adequate. With the special parameters of DECT a service scenario will be described.

5.1 Coverage

As stated earlier, a countrywide coverage is not appropriate with DECT. At the same time a minimum traffic level is required to make a low cost cordless mobile service in order to cross the mass market barrier. From a marketing point of view one has to ask where potential customers would want to use a stationary mobility service. The capability of inhouse coverage seems to be one of the main selling propositions.

Coverage scenario:

- coverage in denser populated parts of cities;

- indoor coverage;

- outdoor coverage as to link the office and residential area.

Figure 5 shows how a typical coverage area would look like.

Figure 5: Map of LEIPZIG

With this scenario the operator has the freedom to decide which areas he would like to cover so that also small operators do have the chance to raise a mobile communications system on the basis of Open Network Provision (ONP) with GSM which ensures the personal phone number with roaming customers. Small operators could, therefore, be e.g. companies running hotels, supermarkets or filling-stations.

Due to the close relationship to GSM it is relatively easy to expand the coverage by either using a DECT - GSM transponder mounted in vehicles or by using a so called Dual Mode Handheld (DMH) comprising DECT and GSM or Digital Cellular System 1800 (DCS 1800) in one handset. By this means the service area could be country-wide (Europe-wide) and at the same time indoor coverage could be provided at appropriate costs.

5.2 Service requirements

Service concepts for cordless access systems generate special requirements for the handsets, for example the size and weight of the handset, the speech quality and the extended talk and standby time without battery recharging.

Since cordless phones are designed for stationary mobility, they only operate at low output power and do not need extensive calculations for error correction and RF-equalising. Therefore, it is possible to build small lightweight handsets so that real portability can be achieved. In conjunction with the comparably long standby and/or traffic times with one battery charge real personal communications can be implemented.

For a public access service secure, fast, and convenient initialisation is a main issue. Operators could choose between two methods of initialisation; either

- all identity related information is separated from the handset by using a smart card; or

- the relevant data are loaded into the handset via the air.

The latter case has to be implemented in a way that the information being stored in the handset cannot be read out and used for fraud, and that the data transmitted over the air cannot be eavesdropped. From an operating point of view, the smart-card solution is preferable but due to the size and the price of the equipment some restrictions exist (see subclause 5.3).

Common methods of authentication and ciphering have to be installed so that fraud and eavesdropping can be prevented. The appropriate mechanisms could be taken either from the GSM standard or DECT standard both supporting the same variety of features and are similar structured.

In order to have the possibility to give the user additional call information, a display could be built into the handset. This is especially important in a competing communications environment so that, for example, operator identification can be provided to the user in order to allow free choice of operators.

5.3 Basic service profile

Market research indicates that speech transmission is the main application required. Advanced data transmission (e.g. Local Area Network (LAN), Wide Area Network (WAN)) should not be excluded but it is not clear if the additional investment for this feature in the network does not prevent the low pricing necessary for the generation of a mass market. Anyhow, the possibility of using modems on the speech paths exists so that data applications like telefax or slow data transmission (at least 4 800 bit/s) are feasible.

Summing up all the recognitions and requirements stated up to this point a basic service profile can be derived:

1) Basic functions:

- adequate inexpensive handsets;
- coverage of denser populated parts of cities;
- indoor and outdoor coverage;
- stationary mobility = pedestrian phone;
- common air interface (GAP + DECT/GSM interworking profile).

2) Basic features:

- speech transmission as the main application;
- protection of speech/data by ciphering;
- fraud protection by authentication procedure;
- automatic location updating;
- roaming between cluster and coverage areas;
- roaming between operators.

3) Additional features:

- data transmission via modem or direct later on;
- initialisation by DECT Authentication Module (DAM)/Subscriber Identity Module (SIM) or over the air;
- inter cell/intra cluster handover;
- inter system handover possibly at a later stage;
- display paging services;
- voice paging services;

6 Technical impacts

When a cordless access system is planned on the basis of the GSM Network Subsystem (NSS), consisting of GSM-MSC plus databases, several interfaces or Interworking Units (IWU) will have to be specified or modified. Those affected are the air interface, the network interface, and the smart-card interface.

6.1 Network interface

GSM-Base Station Subsystems (BSS) are attached to the MSC via the A-interface. The A-interface comprises the call-control functions, the radio-resource management and the mobility management.

The Digital Signalling System No. 1 (DSS1) interface is going to be implemented into the MSC´s of some network providers to attach Private Branch eXchanges (PBXs) to these MSCs. This interface is not specified in GSM but in ISDN. The DSS1 interface contains call control functions only and is, therefore, not applicable if any mobility management is required. Figure 6 shows the situation where both interfaces are implemented.

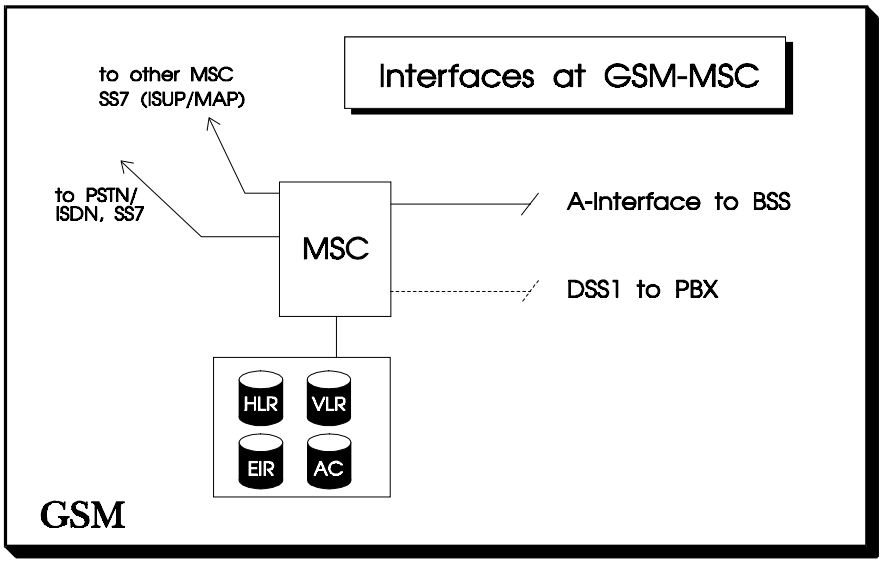

Figure 6: Interfaces at GSM-MSC

As a cordless access system with DECT requires protocol elements of mobility management for the communication with the databases attached to the MSC, it is obvious that the DSS1 interface as it stands cannot be used to attach the public access system to the MSC. Today's situation is that only the A-interface provides the necessary functionality. This interface could be used by the DECT system.

If the MSC has to be prepared for the support of mobility, where the service also has to be offered in ISDN environments, it is highly desirable to implement a second mobility supporting interface into the switch. This interface could be based on ISDN comprising the protocol elements of the DSS1 interface and a mobility management based on the mobility management of the A-interface ("DSS1+", see note).

NOTE: DSS1+ is a working expression for an Euro-ISDN subscriber interface extended by functions to support mobility. The DSS1+ interface is not specified, neither in ISDN nor in GSM.

This interface would support general mobility with either directly attached DECT equipment or via Private Telecommunications Networks (PTNs) as an intermediate system. Figure 7 depicts the evolutionary situation:

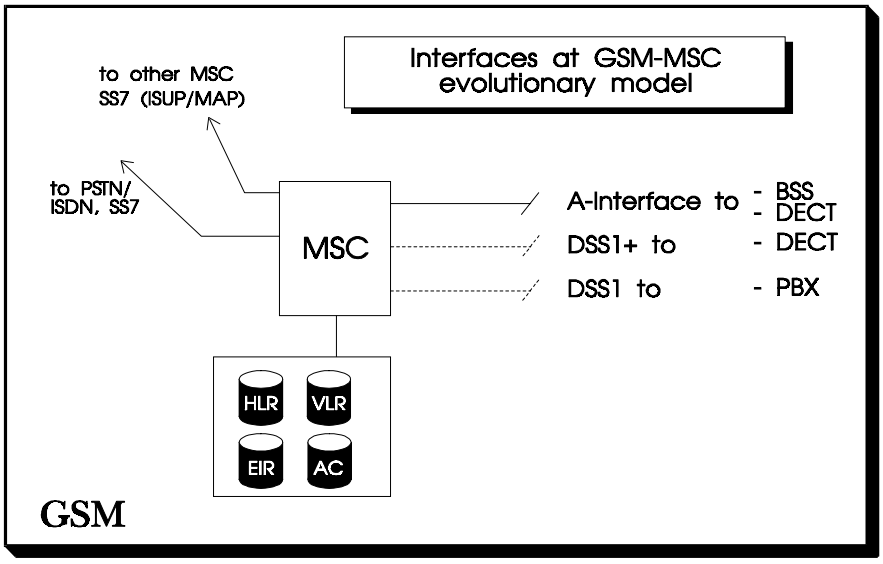

Figure 7: Interfaces at GSM-MSC - example for an evolutionary model

In principle the A-interface is providing all the functions necessary for attaching the DECT network to the MSC. This option has at the same time the advantage that no further work is necessary for standardization of a new interface and is, therefore, faster in realisation.

The future evolution of a DECT mobility service within, and between, several networks is not restricted to GSM network subsystems. A non GSM specific interface gives the opportunity to integrate private and business networks into the public access mainframe. With a DSS1+ interface, network operators could offer DECT mobility services to the public (ONP concept).

The GSM Mobile Application Part (MAP) of SS7 is regarded to be sufficient for the provision of mobility in, and between, networks. Nevertheless the Application Part of the Intelligent Network (INAP) could use a different structure to support mobility.

6.2 Air interface

The DECT specification is a description of an air interface comprising protocol elements necessary for a whole variety of applications. Due to the different applications and possible realisation scenarios provision for interoperability is not given automatically.

To make interoperability between FPs and PPs of different manufacturers possible, the Public Access Profile (PAP) was defined on the basis of the telepoint application. Advanced telecommunications in a GSM environment (or PBX environment) is not fully supported with this PAP.

In response to requests from regulatory bodies, ETSI Technical Subcommittee (STC) RES 3 has started to develop a GAP. This GAP is expected to be mandatory for all DECT speech equipment. GAP will describe the minimum requirements to achieve interoperability between PPs and FPs. To gain access to mobility supporting networks additional requirements are needed.

To achieve an interoperable access to the GSM environment, the DECT/GSM interworking profile is being developed.

The according conformance test specifications are already planned. In order to achieve interoperability with full functionality in DECT networks attached to GSM, the DECT equipment has to fulfil these requirements.

Figure 8 shows the requirements to DECT equipment attached to GSM under the precondition that the GAP relating TBR is accepted by the regulatory bodies.

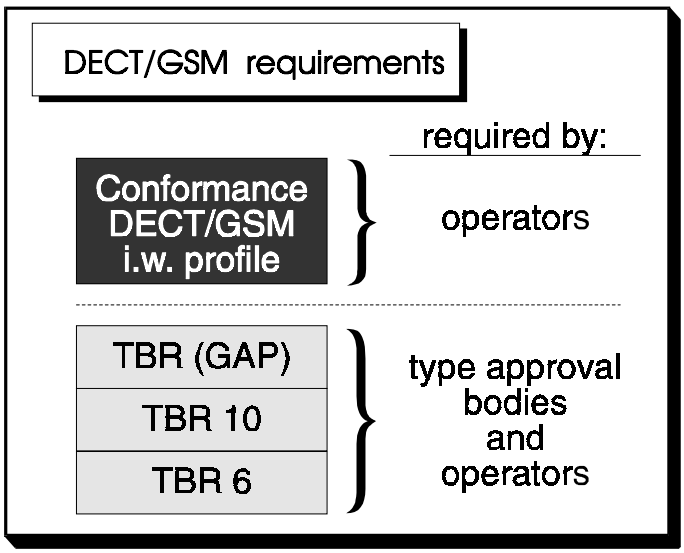

Figure 8: Requirements to DECT/GSM equipment

6.3 Smart-card interface

Smart-cards in telecommunications provide the possibility to separate identity related information from mobile stations. As the GSM specification stipulates the use of smart-cards (SIM) and the GSM based DECT public access system could use the same registers as the GSM system the usage of these cards will be mandatory in a GSM based DECT service as well.

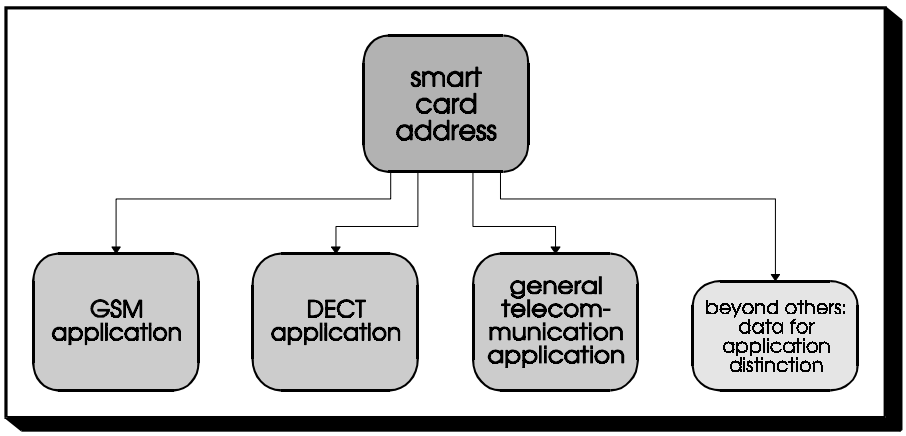

Figure 9: Different applications on the DAM smart card

The DECT smart-card specification DAM is not identical with the GSM SIM. There are for example different identities to handle. To be able to use the same smart-card in a GSM and DECT handset, the DAM specification has to be modified, such that it describes the handling of a GSM application in a DECT handset (see figure 9).

6.4 Multicell systems

An adequate service quality in a public access system can only be obtained by implementation of multicell systems. Within multicell cluster intracell and intercell seamless handover is necessary.

Handover between adjacent cluster is foreseen as a future development.

7 Strategic aspects

7.1 Interoperability

Manufacturers of telecommunications equipment seek to distinguish their products from those of their competitors. This may limit the level of interoperability.

The Commission of the European Communities (CEC) wishes to have interoperability. Therefore in Council Recommendation 91/288/EEC [21] compatibility to public access applications is explicitly stated.

There is a need for DECT network providers to have interoperability in public access systems especially for mobility supporting procedures as they are realised in GSM.

Manufacturers have an interest in interoperability because market studies indicate that the terminal market will significantly grow if the terminals are usable for roaming customers.

To meet the two requirements, interoperability and distinction between products of different manufacturers, special features, e.g. based on PBX-capabilities, could be realised in a way indicated in figure 10.

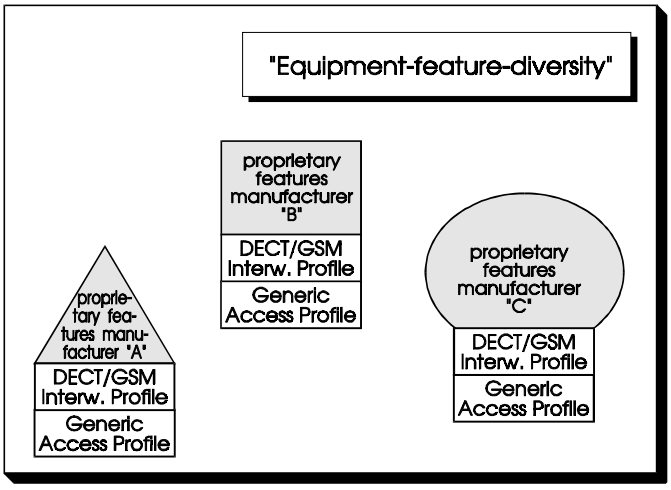

Figure 10: Equipment based on GAP and DECT/GSM interworking profile

7.2 Standardisation

It is crucial for the implementation of the DECT public access that provision for interworking of equipment is being made. As outlined even GAP after being finalised will not fulfil this demand for advanced public telecommunications.

Bearing in mind that timing of implementation is very important and that the GSM fixed network is the only global network making provision for the required mobility features, it makes sense to put all efforts into the finalising of the DECT/GSM interworking profile.

7.3 Commission of the European Communities (CEC)

The development of a strong European telecommunications market on the applications and the manufacturing side is highly dependent on a well defined competitive situation. As mentioned earlier the growth of the cordless market is dependent on the interoperability of equipment of different manufacturers by which the roaming of customers between several operators, private and public, becomes possible.

In this environment, operators who do not wish to make a huge investment for the implementation of a country-wide mobile system will get the opportunity to launch local mobile services and, therefore, create a climate of increasing competition with the following stimulation of the European market strength.

It is essential that the CEC continues in supporting ETSI standardization work. The basic ETSs are to be followed by accompanied TBR´s and CTR´s. Further support of the different validation projects of DECT would be very helpful.

As GSM is part of the ONP project, the described service scenario could be included in the ONP Green Book.

History

Document history	
July 1995	First Edition
January 1996	Converted into Adobe Acrobat Portable Document Format (PDF)

ISBN 2-7437-0175-7
Dépôt légal : Juillet 1995